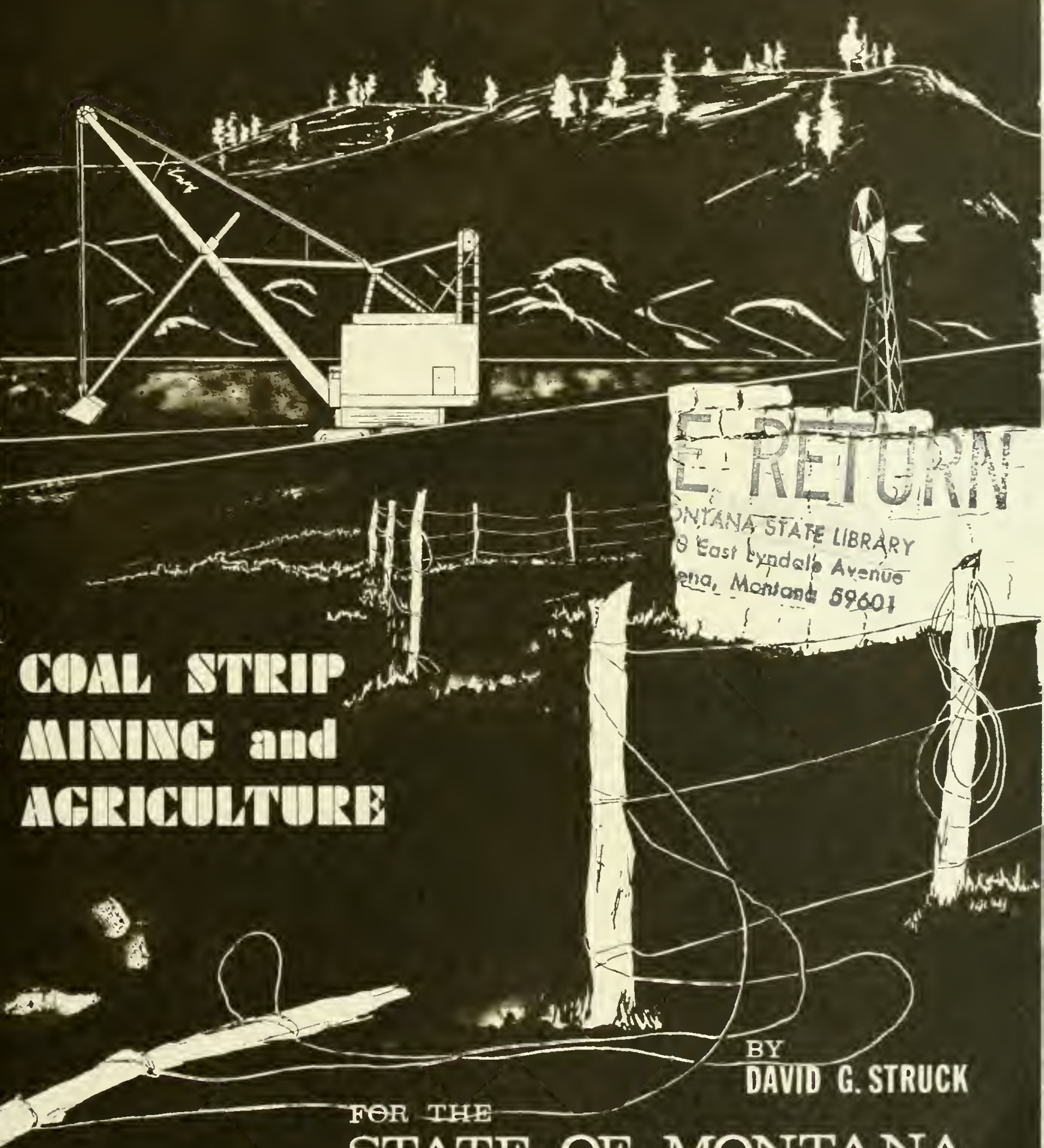
conflictive land use

COAL STRIP MINING and AGRICULTURE



BY
DAVID G. STRUCK

~~FOR THE~~

STATE OF MONTANA
Department of Natural Resources
and Conservation

JUNE 1975

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CONFLICTIVE LAND USE: COAL STRIP MINING AND AGRICULTURE

by

David G. Struck

for the

Montana Department of Natural Resources and Conservation

June 1975

Project Advisory Committee:

Glenn R. Smith, Project Supervisor. Supervisory Soils Scientist, Resources and Planning Bureau, Water Resources Division, Montana Department of Natural Resources and Conservation

Robert E. Matson, Chief, Energy Division, Montana Bureau of Mines and Geology

Charles R. Meyer, Administrator, Centralized Services Division Montana Department of Agriculture

Don Breiby, Chief, Cartography Bureau, Centralized Services Division, Montana Department of Natural Resources and Conservation

Frank Culver, Special Staff, Montana Department of Natural Resources and Conservation

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ABSTRACT

Development of southeastern Montana's vast low-sulfur coal reserves will have an effect on the area's existent agricultural land use. To determine to what geographical extent these land uses (and potential land uses) overlap within a specific study area, a map, "Present and Potential Land Use in Southeast Montana: Strippable Coal Reserves and Agriculture," was constructed, displaying the areal extent of strippable coal reserves, rangeland, irrigated land, irrigable land (classes 1, 2, and 3), and dry cropland. The map indicates that approximately 4% of the dry cropland and approximately 3% of the irrigated land in the study area are underlain by strippable coal.

Land use impacts will ultimately be greater than these geographical conflicts. It is not known what effect strip mining will have on the area's ground-water resource, although it can be confidently predicted that some wells and springs will be physically destroyed by the mining. In addition, although the socioeconomic impacts of strip mining may not be great, the socioeconomic impacts of associated development, such as the construction of coal-fired power plants, can be severe.

I. INTRODUCTION

Since its settlement, southeastern Montana has been used almost exclusively for cattle ranching and the growing of dryland and irrigated crops. The recent increase in demand for new, low-pollution national energy sources has caused widespread interest in the low-sulfur coal deposits of the Fort Union formation, which underlies most of southeastern Montana. Anticipating the effects of large-scale coal development in Montana, many opponents to such development fear that the loss of crops resulting from the strip mining of Fort Union coal would be extensive and would greatly affect the state.

The purpose of this project, conducted under the auspices of the Western Interstate Commission of Higher Education (WICHE), was to determine the extent of potential land-use competition between agriculture and the strip mining of coal in southeastern Montana. To determine to what geographical extent these land uses (and potential land uses) overlap, a map, "Present and Potential Land Use in Southeast Montana: Strippable Coal Reserves and Agriculture" (in back envelope), was constructed. The map displays the areal extent of strippable coal reserves, rangeland, irrigated land, irrigable land (classes 1, 2, and 3), and dry cropland. Although most of the strippable coal in the study area underlies rangeland, this report concentrates on potential land-use conflicts between strip mining of coal and irrigated and dryland farming; irrigable land is also considered.

Strippable coal within the Crow and Northern Cheyenne Indian reservations was neither mapped nor its potential conflicts with agricultural land use considered because comprehensive data on coal within the reservations were not available and because mines within the reservations may not be subject to the Montana Strip Mining and Reclamation Act. The Montana Department of State Lands is now investigating whether the Act applies to these mines.

II. STUDY AREA DELINEATION

In delimiting the study area (figure 1), consideration was given to the availability of data, the extent of the Fort Union formation, hydrological boundaries, and political boundaries.

Though the Fort Union formation extends through eastern Montana, from Canada to Wyoming, the study area was limited to 8,284,278 acres south of the Yellowstone River, including parts of Big Horn, Carter, Custer, Fallon, Powder River, Prairie, Rosebud, and Treasure counties, but excluding land within the Crow and Northern Cheyenne Indian reservations. Because most of the current commercial mining is being done south of the Yellowstone River, and because the most comprehensive data on strippable coal concern the same region, the study area is appropriate.

The study area is bounded on the west by the Rosebud Creek-Little Bighorn divide and the Tullock Creek-Sarpy Creek divide; on the east, by the divide between the Powder River and Little Missouri River drainages and by the northern boundary of the O'Fallon Creek drainage; on the north, by the Yellowstone River; and, on the south, by the Montana-Wyoming border.

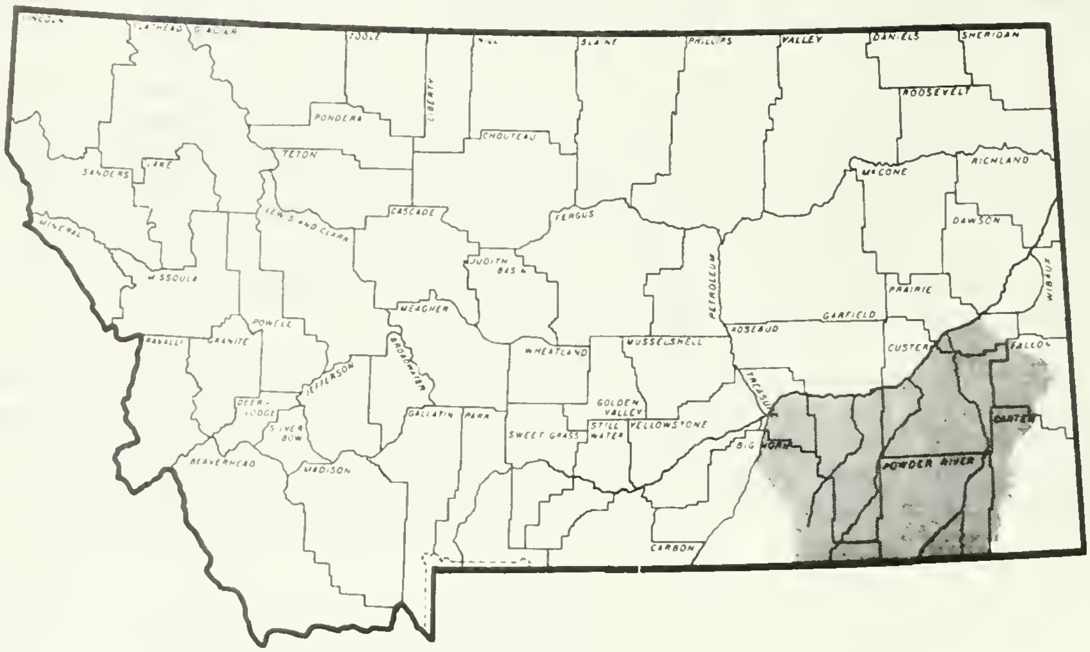

Figure 1. Study area location within Montana

III. STRIP MINING OF COAL IN THE STUDY AREA

The amount of land underlain by strippable coal (that under less than 150 feet of overburden) in the study area, excluding coal on the Crow and Northern Cheyenne Indian reservations (and in the Sarpy Creek area, where the Crow tribe controls mineral rights), is 770,079 acres (9.3% of the study area). As shown on the map, strippable coal underlies portions of all types of agricultural land in southeastern Montana. Table 1 lists the acreage of strippable coal reserves and tons of coal per acre of land for selected deposits in the study area. Indicated reserves are subject to change with more complete geologic study.

Operators of Montana strip mines must each year secure a permit from the Montana Department of State Lands under the Montana Strip Mining and Reclamation Act (Section 50-1034 et seq., R.C.M. 1947). The Act also provides that land which cannot be reclaimed to specified criteria cannot be mined. Other acts regulating strip mining of coal in Montana, also administered by the Department of State Lands, are the Strip Mined Coal Conservation Act (Section 50-1401 et seq., R.C.M. 1947) and the Strip Mine Siting Act (Section 50-1601 et seq., R.C.M. 1947).

Mining Method

According to Section 50-1044 of the Montana Strip Mining and Reclamation Act, the method known as area strip mining must be used for all strip mines in Montana.

> *In this type of mining generally an initial trench or box cut is made through the overburden to expose the coal. As the overburden is removed, it is thrown backwards onto the land behind the direction of mining to form the initial spoil piles. After the overburden is removed, the coal seam is taken. Subsequent cuts are made parallel to the original cut with the overburden being thrown back (backfilling) into the open trench left by the previous cut. The final cut leaves an open trench bounded on one side by the backfilled previous cut and on the other by a steep-sided face referred to as the final highwall which is as high as the sum of the overburden and coal removed. (Montana Department of Natural Resources and Conservation 1974, p. 261)*

Table 1. Reserves, Acreage, and Tons of Coal Per Acre of Land for Selected Strippable Coal Deposits

Coal Deposit	Coal Bed	Reserves, million tons	Acreage	Average tons/acre
Decker	Anderson & Dietz 1&2	2,239.99	25,523	87,763
Deer Creek	Anderson & Dietz 1&2	495.65	14,214	35,397
Roland	Roland	218.04	12,076	18,055
Squirrel Creek	Roland	133.41	6,208	21,490
Kirby	Anderson	216.52	5,655	38,285
	Wall	473.69	5,952	79,579
	Dietz	834.35	17,516	47,630
	Canyon	158.53	4,066	38,983
Canyon Creek	Wall	1,884.25	23,859	78,974
	Brewster-Arnold	65.86	2,067	31,859
Birney	Brewster-Arnold	180.55	6,969	25,905
Poker Jim Lookout	Anderson and Dietz	872.65	19,609	44,501
Hanging Woman Creek	Anderson	1,583.29	30,547	51,830
	Dietz	1,120.96	43,654	25,678
West Moorhead	Anderson	883.74	19,660	44,949
	Dietz	397.49	20,416	19,469
	Canyon	690.19	22,547	30,611
Poker Jim Creek-O'Dell Creek	Knobloch	373.29	7,890	47,311
Otter Creek	Knobloch	2,075.55	25,791	80,475
Ashland	Knobloch	2,696.20	27,200	99,125
	Sawyer A and C	357.49	20,262	17,643
Colstrip	Rosebud	1,439.26	33,379	43,118
Pumpkin Creek	Sawyer	2,426.50	45,695	53,102
Foster Creek	Knobloch	708.13	27,801	25,470
	Terret	460.87	27,462	16,782
	Flowers-Goodale	258.90	14,444	17,924
Broadus	Broadus	739.82	18,429	40,142
East Moorhead	T	525.21	15,559	33,756
Diamond Butte	Canyon	418.02	21,363	19,566
Goodspeed Butte	Cook	628.95	13,446	46,775
Fire Gulch	Pawnee and Cook	336.69	8,486	39,674
Sweeney Creek-Snyder Creek	Terret	326.33	10,921	29,880
Yager Butte	Elk and Dunning	1,175.86	26,924	43,673
	Cook	312.02	14,507	21,507
Threemile Buttes	Canyon and Ferry	225.40	13,836	16,289
Sonnette	Pawnee	320.25	8,224	38,940
	Cook	362.98	10,470	34,668
Home Creek Butte	Canyon and Ferry	217.21	4,851	44,774
Little Pumpkin Creek	A. Sawyer, C&D, X&E	215.83	8,534	25,290
Sand Creek	Knobloch	267.34	5,952	44,915
Beaver Creek-Liscom Creek	Flowers-Goodale, Terret, and Knobloch	627.49	25,926	24,203
Greenleaf Creek-Miller Creek	Rosebud, Knobloch, and Sawyer	453.71	14,918	30,413
Pine Hills	Dominy	193.87	6,022	32,191
Knowlton	Dominy (M & L)	747.51	19,613	38,112
	Dominy (U)	120.31	4,448	27,048
		32,024.93	770,079	

Source: Matson and Blumer 1973

The Act stipulates that all topsoil and any material suitable for topsoiling be removed before this process begins and stockpiled in such a way that it will not be compacted or contaminated.

Reclamation

The Montana Strip Mining and Reclamation Act requires that reclamation begin as soon as possible after commencement of and be performed concurrently with strip mining.

Following removal of the coal and replacement of the overburden, the area is graded to the approximate original contour of the land; with the exception of the final highwall, which may be graded to a 33% (20^{o}) slope, no slope in the mining area is to exceed 20% (12^{o}) after regrading. The spoil is left roughened to prevent slippage between topsoil and spoil surfaces. Salvaged topsoil is then redistributed on the graded area. Revegetation must begin during the first opportune season, and must result in a "suitable permanent diverse vegetative cover" capable of withstanding grazing pressure from a quantity of wildlife and livestock comparable to that which the land could have sustained prior to stripping.

Reclamation costs in the study area vary with topographic conditions and the severity of the disturbance, among other factors. At one typical mine, reclamation costs are estimated at $2,200 per acre for stripped lands, $3,300 per acre for facility areas (such as buildings and crusher), and $200 per acre for associated disturbances, such as access roads (Montana Department of Natural Resources and Conservation 1974). To ensure that mine operators adequately and lawfully reclaim land that they have stripped, they are required to file with the state a bond for an amount sufficient to allow the state to reclaim the land as provided by the 1973 reclamation law should the mine operator default. Mine operators in the study area are bonded for as little as $800 per acre or as much as $6,500 per acre, depending on mining circumstances and land conditions (Solomon 1975).

The oldest reclaimed plots of land in southeastern Montana have been supporting vegetation for approximately five years. Legal and economic considerations aside, it is believed that the technological capability exists for reclaiming stripped lands for range or crop production, if the chemical and physical properties of the topsoil and subsoil are favorable. Besides soil characteristics, successful reclamation depends on moisture, adequate and proper seed bed preparation, the time of seeding, and proper conservation practices. Although the financial cost may be high, reclamation efforts in Montana will probably be successful if the provisions of the Montana Strip Mining and Reclamation Act are followed.

Some reclaimed plots in southeastern Montana, subjected to a moderate fertilization program, have yielded 40 bushels of barley per acre (Hodder 1975). However, in accordance with the provisions of the Act, the Department of State Lands is allowing fertilization and irrigation for a short period only (usually for one year after seeding) to establish the permanent vegetative cover.

Agencies currently conducting research in reclamation of strip-mined land include the Intermountain Forest and Range Experiment Station of the U. S. Forest Service and the Montana Agricultural Experiment Station at Montana State University.

IV. NATURAL AND CULTURAL ENVIRONMENT OF THE STUDY AREA

Natural Environment

Though any exhaustive analysis of the natural environment of an area would include such elements as animal, bird, and fish populations and vegetation types, this report will investigate only climatology, hydrology, and geology, those factors of the natural environment most directly related to mining, reclamation, and agriculture.

Climatology

Warm summers and cold winters characterize the climate of the study area. Surface humidity is low; prevailing wind speeds are moderate. Total annual precipitation varies from 12 to 16 inches. In a normal year, over 70% of the total precipitation occurs during the April-to-September growing season. Maximum monthly precipitation usually occurs in May or June. This precipitation pattern, coupled with a relatively long freeze-free season (from less than 100 days in the Rosebud Mountains to 150 days in the Miles City vicinity), make agriculture viable in the study area (Montana Department of Natural Resources and Conservation 1974).

Hydrology

The entire study area is within the drainage of the Yellowstone River. The Yellowstone, Powder, and Tongue rivers, O'Fallon Creek, and parts of Rosebud Creek are considered perennial, although only the Yellowstone has never been dry. There are numerous intermittent streams, many with small reservoirs for agricultural and domestic use. In general, the availability of surface water is limited.

Strip mining the alluvial land of the stream valleys may result in subsurface pollution, dewatering of the ground-water resource, and alteration of runoff channels, which will affect irrigated and irrigable cropland at the mine site and downstream.

The sources of ground water are the alluvium along drainages, and the sandstones and coal beds in the Fort Union and Hell Creek formations. At present no comprehensive evaluation has been completed of the ground-water quantity and quality of the area; however, both the U. S. Geological Survey and the State of Montana are conducting ground-water investigations in the study area. Little is known at this time, however, about the effects of strip mining on ground-water quality and supply. VanVoast (1974) has

summarized existing knowledge on this complex subject:

> *Mine spoils are overburden materials removed from above the coal and placed behind the mining operation. They replace the pre-existing aquifers and other materials disturbed by mining and are new physical and chemical factors in the hydrologic system. Their average permeabilities are different and have different directional properties than before mining. Chemical constituents not readily available for dissolution by ground water in the stratified overburden are suddenly available when the overburden materials are stripped and replaced in an unstratified condition. Because mine spoils are such new and rare entities in the natural hydrologic system of the Fort Union coal region, little is known about their hydrologic characteristics. Their newness in the system precludes the availability of historical data for the prediction of future hydrologic effects. Their rarity in the complex system restricts the projection of spoil-water data from available research areas to locales having different physical and chemical hydrologic conditions. Current research efforts on the hydrology of spoils are centered near Colstrip at the Rosebud and Big Sky mines and have not yet generated data for adequate understanding of spoils at those mines; the question of projectability of the interpretations to other mine areas cannot be faced until these first research efforts are completed. Data currently available that may be pertinent to hydrologic characteristics of spoils provide a framework from which to speculate but not to conclude.*

Despite this lack of knowledge, limited predictions can be made about the impacts of strip mining on ground water quantity. Discussing the effects of Western Energy Company's mining of Rosebud coal near Colstrip, VanVoast and Hedges (1974) state:

> *Depending on the sizes of actual mine areas, as many as 19 wells and 3 springs can be physically destroyed during the mining operations. In addition, 4 wells will probably experience severe water-level declines and may become unusable. Five wells and 2 springs will probably experience moderate water-level and yield declines, possibly decreasing their seasonal usability. Three wells and 1 spring will experience slight water-level and yield declines....*
>
> *Hydrologic conditions in affected areas will adjust after mining is completed until a post-mining dynamic equilibrium is reached.*

Geology

Nearly horizontal sedimentary strata underlie the study area and have produced its characteristic landscape. Though elevations range from 2,120 feet along the Yellowstone River below Fallon to 5,205 feet in the Rosebud Mountains along the western boundary of the study area, local relief seldom exceeds 300 feet. For the most part, the area consists of dissected uplands (the divides between the major streams), the stream valleys, and terraces ranging in elevation from a few feet to more than 1,000 feet above the bed of the Yellowstone River.

The bedrock underlying most of the study area is the Fort Union formation, of Paleocene age. Within the Fort Union formation there are three members--the Tongue River, the Lebo, and the Tullock. Most of the economic coal deposits as defined by today's technology lie in the Tongue River member.

The Tongue River member ranges from 1,200 to 1,700 feet in thickness and forms the top layer of the Fort Union formation. In the northern part of the study area much of the member has been eroded away. Because the coal deposits in this member are up to 80 feet thick (Matson and Blumer 1973), flat-lying, and not deep (under less than 150 feet of overburden in many areas), they are economically feasible to strip mine.

Cultural Environment

Though population is also mentioned here, the element of the cultural environment of most importance for this study is land use.

Population

Because the study area boundaries do not coincide with county lines, precise population figures could not be obtained from census data. Extrapolating from census information gives an approximate 1970 population of 30,000 for the study area. Population density varies from one to three persons per square mile.

Land Use

Other than coal development, discussed above, agricultural land use is the only study area land use of sufficient magnitude to be significant in this study.

Dry Cropland. Dry cropland is considered to be that used for the growing of dryland agricultural crops which are produced annually; this definition excludes rangeland where hay is occasionally harvested. Dryland crop acreage is scattered in small to medium blocks, except on the benchland of the Yellowstone River and in Fallon County, where acreage blocks are larger and more concentrated. Approximately 4% (13,000 acres) of the 309,000 acres of dry cropland in the study area is underlain by strippable coal. Of this 13,000 acres, over 4,000 are irrigable.

As shown in table 2, significant dryland crops grown in study area counties in 1973 were wheat, corn, oats, barley, and hay.

Irrigated and Irrigable Land. The map shows presently irrigated land (approximately 100,000 acres) and three classes of irrigable land. The irrigated lands occur in the valleys of the Yellowstone and its tributaries and on benchlands. The map shows that approximately 3,000 acres (3% of the irrigated land in the study area) are underlain by strippable coal. Table 3 shows acreages and yields of significant irrigated crops in the study area.

The system by which irrigable lands were classified is presented in the Appendix. Some irrigable land is used at present as dry cropland, due to the high cost of water delivery systems, a lack of available water, and, possibly, a lack of demand even when water is available.

Timberland and Rangeland. Timberland in the study area includes the Custer National Forest and surrounding timberland in the Indian reservations and under private ownership. The amount of timber harvested from this land is low compared to the yield of more productive forests in western Montana and the Pacific Northwest. The Northern Cheyenne tribe receives 50% of its income from timber harvested on reservation lands (Montana Department of Natural Resources and Conservation 1975), but this report does not consider land use conflicts within the borders of the reservation. Most of the Custer National Forest within the boundaries of the study area is used primarily as rangeland. For the purposes of this report and the accompanying map, timberland will be considered as rangeland.

Land not being used as dry or irrigated farmland is probably being used for range (shown as white on the map). This classification excludes land that is occupied by cultural features (such as towns, residences, and roads) and physical features (such as rivers) which cannot support range animals. No attempt at evaluation of the quality of the range has been made in this study. On some of the rangeland grass can be cut occasionally for hay when moisture permits, while other areas can barely support one animal unit on 50 acres.

Rangeland supports the study area's major land use--livestock grazing. Livestock from the eight counties partially included in the study area form a significant portion of the State total; on January 1, 1974, there were in the eight counties a total of 195,700 sheep and lambs (compared to a Montana total of 710,000) and a total of 689,000 cattle and calves (compared to a Montana total of 3,380,000) (Montana Department of Agriculture 1974).

TABLE 2
ACREAGES AND AVERAGE YIELDS OF DRYLAND CROPS IN 1973

County ***	CROP			
	All Wheat		Barley	
	Acres Harvested	Yield per Acre (Bushels)	Acres Harvested	Yield per Acre (Bushels)
Big Horn	62,200	25.3	19,400	28.0
Carter	21,800	25.1	8,800	35.0
Custer	12,300	27.7	7,900	34.0
Fallon	47,700	29.3	27,700	41.0
Powder River	26,700	35.6	6,000	41.0
Prairie	38,300	32.8	8,300	42.0
Rosebud	21,000	31.4	9,500	37.0
Treasure	4,100	28.8	1,000	47.0

	Oats		Corn (Silage Only)	
	Acres Harvested	Yield per Acre (Bushels)	Acres Harvested	Yield per Acre (Tons)
Big Horn	1,500	47.0	*	*
Carter	7,400	35.0	400	6.0
Custer	2,200	42.0	300	7.0
Fallon	7,500	43.0	1,000	7.0
Powder River	6,700	45.0	*	*
Prairie	2,600	42.0	400	8.0
Rosebud	3,400	56.0	*	*
Treasure	200	48.0	*	*

	All Hay		Alfalfa Hay		Alfalfa Seed	
	Acres ** Harvested	Yield per Acre (Tons)	Acres ** Harvested	Yield per Acre (Tons)	Acres ** Harvested	Yield per Acre (Pounds)
Big Horn	45,700	1.49	22,500	1.90	1,500	89
Carter	38,200	1.22	28,000	1.30	4,900	104
Custer	24,700	1.41	8,600	2.00	200	85
Fallon	33,400	1.28	23,800	1.40	100	80
Powder River	40,200	1.11	30,800	1.15	5,300	95
Prairie	12,300	1.15	3,500	1.51	300	110
Rosebud	14,400	.83	9,800	.90	700	112
Treasure	10,300	.96	6,600	1.00	800	110

SOURCE: Montana Department of Agriculture 1974.

* Fewer than 100 acres of the indicated crop were harvested in this county.

** Because these acreages were not discernable on the ASCS aerial photos, they were not mapped.

*** Figures in this table are total county figures, including those portions of the counties outside the study area.

TABLE 3
ACREAGES AND AVERAGE YIELDS OF IRRIGATED CROPS IN 1973

County **	CROP					
	All Wheat		Barley		Oats	
	Acres Harvested	Yield per Acre (Bushels)	Acres Harvested	Yield per Acre (Bushels)	Acres Harvested	Yield per Acre (Bushels)
Big Horn	4,300	41.3	1,900	46.0	800	64.0
Carter	*	*	*	*	*	*
Custer	1,100	45.6	1,400	51.0	1,800	68.0
Fallon	*	*	*	*	*	*
Powder River	100	50.0	300	65.0	*	*
Prairie	300	44.6	*	*	1,000	66.0
Rosebud	1,500	41.6	1,400	72.0	800	69.0
Treasure	400	52.5	1,100	75.0	400	70.0

	Corn		Sugar Beets		Dry Beans	
	Acres Harvested	Yield per Acre (Tons)	Acres Harvested	Yield per Acre (Tons)	Acres Harvested	Yield per Acre (100-lb. bags, cleaned)
Big Horn	8,100	17.0	*	*	900	16.0
Carter	*	*	*	*	*	*
Custer	6,600	19.0	2,400	22.0	100	16.0
Fallon	*	*	*	*	*	*
Powder River	500	19.0	*	*	*	*
Prairie	3,000	19.0	2,170	19.0	200	17.0
Rosebud	4,900	16.0	1,270	19.8	100	18.0
Treasure	3,100	19.0	4,030	23.5	600	19.0

	All Hay		Alfalfa Hay		Alfalfa Seed	
	Acres Harvested	Yield per Acre (Tons)	Acres Harvested	Yield per Acre (Tons)	Acres Harvested	Yield per Acre (Pounds)
Big Horn	27,300	2.51	21,500	2.73	1,000	105
Carter	17,300	1.50	9,500	1.82	1,600	135
Custer	11,100	3.01	7,200	3.72	600	130
Fallon	6,900	2.35	6,500	2.43	300	125
Powder River	19,100	1.92	13,500	2.21	2,000	100
Prairie	6,100	2.64	4,900	2.94	200	130
Rosebud	23,200	2.47	21,800	2.52	1,800	145
Treasure	4,800	2.85	3,500	2.94	700	93

SOURCE: Montana Department of Agriculture 1974

* Fewer than 100 acres of the indicated crop were harvested in this county.

** Figures in this table are total county figures, including those portions of the counties outside the study area.

V. POTENTIAL LAND USE CONFLICTS

Land Taken Out of Agricultural Production

The land-use conflict of most immediate concern, and the one most directly addressed by this report, is the temporary or permanent loss of irrigated and dry cropland. Approximately 16,000 acres of cropland in the study area are underlain by strippable coal. Although some of this land will not be stripped for many years, and some of it may never be stripped, all of it that is mined will be removed from agricultural production during the mining process.

With favorable soil characteristics, fertilization, sound conservation practices, and perhaps sprinkler irrigation, the land could be returned to crop production. However, to provide proof that long-term reclamation can be accomplished, more years of research and observation are necessary.

In addition, the Montana Strip Mining and Reclamation Act stipulates that stripped land, to be considered reclaimed, must be able to support a "suitable permanent diverse vegetative cover." Land used as dry cropland after stripping would not satisfy this legal requirement, and therefore would not have been lawfully reclaimed by the mining company. Consequently, stripped land in Montana which previously was cropland is being reclaimed to support a permanent diverse vegetative cover, rather than a nonpermanent, nondiverse crop (Solomon 1975). When the permanent vegetative cover has been satisfactorily established and the bond for the land has been released by the Department of State Lands (a statutory minimum of five years after mining), the land can legally be returned to crop production.

The impacts of this altered land use will vary for each farmer, depending on what sections and what percentage of each farm are underlain by coal. For example, a rancher who, due to strip mining, loses only 200 acres out of 2,000, may still lose most or all of his hayland, and thus all winter feed for his cattle. Similarly, while one dryland farmer may lose only 10% of his acreage to stripping and continue farming the remaining 90%, another may lose most of his acreage and be forced out of business. In general, the cropland acreage underlain by strippable coal occurs in small tracts, the loss of which should not ruin a farmer economically. The impacts cannot be accurately predicted until definite mining proposals are made for the coal under individual ranches.

Socioeconomic Impacts

Social services, such as police, fire, and medical services, and public facilities, such as schools and sanitation facilities, will be strained initially by the influx of the mining population; this strain, however, will not be severe in comparison with that experienced in areas in which major industrial projects, such as coal-fired power plants, are being constructed. Like strip mines, these projects are taxed at a rate proportionate to their

level of completion or development; unlike strip mines, they require large numbers of workers (from several hundred to a few thousand) during the several years necessary for construction. These construction workers and their families severely strain existing public services and facilities (especially in a sparsely populated area like the Fort Union region) during the years that the projects are being taxed at a level lower than their ultimate completed level, providing insufficient funds with which to improve and enlarge existing service systems (Montana Department of Natural Resources and Conservation 1975). In contrast, strip mines require fewer workers during the developmental stage, and are operational and contributing fully to the tax base within fewer years.

Colstrip, Montana (within the study area), and Rock Springs, Wyoming, where mine-mouth coal-fired power plants are being constructed, are experiencing additional social impacts (Montana Department of Natural Resources and Conservation 1974). A schism has developed between the construction population and long-term residents, which may last until the projects are completed and the construction population moves on. In contrast, the mining population is committed for a longer stay; it will be decades before all strippable coal in the study area is mined. Those mine workers who have lived in the study area for a number of years are already being integrated into the community (Montana Department of Natural Resources and Conservation 1974).

Perhaps the greatest socioeconomic impact of strip mining on the study area is its contribution toward changing the area's way of life from agricultural to industrial. It remains to be seen whether agriculture can coexist with increased industrialization in the form of strip mining and associated coal development. At public meetings held by the Department in 1974 concerning coal-fired power plants proposed for the Colstrip area, a definite majority of the residents of rural areas and representatives of agricultural interests, many of them from within the present study area, feared increased industrialization (Montana Department of Natural Resources and Conservation 1975, p. 190-91):

> *The Montana "way of life" or "lifestyle" was...regarded as having an intrinsic value that could not be measured in economic or financial terms. It was generally expressed that this valued "way of life" would eventually be destroyed if Montana were to become an industrial, rather than an agricultural, state.*

Economic Comparison--Dryland Agriculture and Strip Mining

The easiest method of analyzing the economic returns of strip mining and dryland agriculture would be a direct comparison of the average gross returns of each, per acre, in the study area. Such a comparison could well be misleading, both economically and socially. To be valid, an economic comparison of agriculture and mining must consider net returns to each

venture, on a comparable time basis (discounted present value), as well as any external costs and benefits of each. In addition, the broad social implications of replacing agriculture with strip mining dictate the need to assess the distribution of private and social costs and benefits--a difficult undertaking. Next to nothing is known about the long-term viability of using reclaimed mined land for agriculture, and little can be surmised with confidence about the national and international food situation. Considering these factors, the economic impacts of changing land use in southeastern Montana are more complicated than the simple comparison of two numbers. Some observations, however, can be made.

The strip mining of coal intensively utilizes capital, labor, and energy. In the short run, strip mining would be responsible for orders of magnitude more economic activity (jobs, incomes, tax revenues, purchases of capital and expendables), per acre, than agriculture. On the other hand, the extraction of coal from a given piece of land is a one-time operation. When all the coal has been taken, that source of income has been exhausted.

With proper range and crop management, the agricultural land uses in the study area can be expected to produce for many years, perhaps (for all practical purposes) forever. Compared with strip mining, though, dryland or irrigated farming utilizes little labor, capital, or energy; cattle grazing uses even less.

If the land could be reclaimed and returned to dryland or irrigated farming after stripping, both sources of economic activity could be realized--the large, immediate, terminal activity associated with strip mining, and the smaller, perpetual, sustaining activity associated with farming. However, thus far, reclamation of strip-mined lands to cropland capabilities has not been pursued in Montana (Montana Department of Natural Resources and Conservation 1975). Reclaiming to rangeland capability, even if successful, will require an undetermined number of years, during which the land will not be fit for productive use (Montana Department of Natural Resources and Conservation 1974).

VI. SUMMARY

The stated purpose of this project is to determine the extent of potential land use competition between agriculture (primarily dryland farming) and strip mining in southeastern Montana. The majority of the 770,079 acres of strippable coal in the study area underlies rangeland. The map, "Present and Potential Land Use in Southeast Montana: Strippable Coal Reserves and Agriculture," does not indicate a critical potential land use conflict between strip mining and dry or irrigated farmland; approximately 13,000 acres (4%) of the 309,000 acres of dry cropland and 3,000 acres (3%) of the 100,000 acres of irrigated land in the study area are underlain by strippable coal.

All agricultural land that is stripped, whether rangeland or cropland, will be removed from productive use during mining; when it will be returned to agricultural use, and to what type of use, have not yet been determined. Due to legal restrictions, stripped cropland is currently being reclaimed as rangeland, and, even if reclamation efforts are successful, it cannot be reconverted to crop use for a statutory minimum of five years.

Disturbances to the ground-water resource may affect agricultural land use even on land that is not stripped, especially if alluvial lands in the stream valleys are mined.

The strip mining of southeastern Montana coal will contribute to the altering of the area's character from agricultural to industrial, a change regarded as undesirable by at least some study-area residents. Though strip mining of coal would be responsible for a great deal more immediate economic activity than would dryland agriculture, uncertainty concerning reclamation, the world food situation, and the social impacts of industrialization dictates against adopting a narrow economic perspective of the strip mining of southeastern Montana agricultural land.

APPENDIX: METHODOLOGY AND DATA COLLECTION

Mapping

Irrigated land in the study area was mapped at a scale of two inches to the mile in the Water Resources Survey for each county (Montana Water Resources Board 1970; State Engineer's Office 1947, 1948a, 1948b, 1951, 1960, and 1961). In these surveys, Government Land Office plats at a scale of two inches to the mile were used as a base and updated with aerial photographs taken at the time of the Water Resources Surveys. Most of the aerial photographs were acquired from the U. S. Department of Agriculture.

A similar system was used by the Resources and Planning Bureau of the Montana Department of Natural Resources and Conservation (DNRC) to develop land classification maps of the irrigable land in the state, as explained below. Irrigable lands were mapped at two inches to the mile on the Water Resources Survey plats.

Two-inch-to-the-mile plats of irrigable and irrigated land were then projected onto half-inch-to-the-mile county maps. When the present project began, this much of the mapping process had been completed.

It was decided that dry cropland would be mapped on the two-inch-to-the-mile township plat books of each county. The best available source of dry cropland data was the aerial photographs reviewed in the county Agricultural Stabilization and Conservation Service (ASCS) offices. Their eight-inch-to-the-mile dry cropland delineations were transferred to the two-inch-to-the-mile township plats, which required some generalization.

Strippable coal areas were mapped at one inch to the mile in the Matson and Blumer (1973) report by a number of cartographers and geologists who used as base maps U. S. Geological Survey topographic sheets, 1957 Soil Conservation Service aerial photographs, U. S. Forest Service base sheets, and other sources.

The dry cropland data (mapped at two inches to the mile) and strippable coal data (mapped at one inch to the mile) were reduced by projection and plotted on the half-inch-to-the-mile base sheet. Irrigated and irrigable land, already mapped at half-inch to the mile, were added. Even at this scale, the study area was too large to be easily printed. Therefore, the accompanying map, "Present and Potential Land Use in Southeast Montana: Strippable Coal Reserves and Agriculture," was photographically reduced to a scale of slightly less than quarter-inch to the mile.

Statistical Data

The dry cropland acreage (309,000 acres) in the study area was planimetered from ASCS aerial photos. A second dry cropland acreage figure was obtained using the 1969 Census of Agriculture (U. S. Department of Commerce 1974). This figure was derived by assuming a uniform production of dryland crops across an entire county and taking the percentage of the county involved in the study area. The total figure determined by this method was 348,300 acres, for 1968, in dryland crops. The variation between this number and the one derived from ASCS aerial photographs resulted from not all of the aerial photographs being from 1968 flights; two counties had 1967 flights, and one had a 1970 flight. Error caused by this discrepancy was probably not great, considering that the variation between 1968 and 1969 in the 1969 Census of Agriculture total dryland acreage was only 0.45%. A greater probablity of error exists in assuming that the counties produce dryland crops in a geographically uniform manner. Actual acreage in production should be close to the field data.

The irrigable land figures were based on DNRC's broad reconnaissance survey,begun in 1968, using Soil Conservation Service soils surveys, Bureau of Reclamation land classification surveys, and the DNRC's field evaluation.

Land Classification for Potential Irrigation Planning

Land classification is the process by which soils, relief, and climate are systematically appraised, and lands are placed in categories based on similarity of characteristics. Land classification surveys made by the Water Resources Division of the Montana DNRC (unpublished) are specifically designed to establish the degree of suitability of land for sustained irrigation farming. Several criteria determine the desirability of an area for irrigation development: soils and topography, together with frost-free season and mean temperature, define the ability of an area to produce; a dependable water supply must be available, and a market must exist by which to obtain a profit from crops that are produced. Technological advances in sprinkler irrigation have reduced the importance of slope and surface topography constraints on irrigation.

The land classification survey separates land areas into (1) lands having potential for irrigation (termed "irrigable"), and (2) the inferior, "non-irrigable" lands which are unsuited for present or future irrigation because of unfavorable characteristics. The term "irrigable land," as used in this reconnaissance classification, includes land with soils, topography, and drainage features appropriate for irrigation by gravity or sprinkler methods, and that will support sustained irrigated agriculture with proper water management, drainage, and other necessary conservation practices. These lands are divided into classes on the basis of their relative potential for irrigation farming. Class 1 represents irrigable land with

potentially high productive value, class 2 represents irrigable land of intermediate value, and class 3 includes irrigable land of the lowest value that may be suitable for irrigation.

This land classification is based on long-range projection which disregards the water supply presently available for irrigation and the market for crops produced. Any future project development should be based on a detailed study to pinpoint the exact location and limits of the land best suited for irrigation.

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This intern report was read and accepted by a staff member at:

Agency: Montana Department of Natural Resources and Conservation

Address: 32 South Ewing Helena, Montana 59601

This report was completed by a WICHE intern. This intern's project was part of the Resources Development Internship Program administered by the Western Interstate Commission for Higher Education (WICHE).

The purpose of the internship program is to bring organizations involved in community and economic development, environmental problems and the humanities together with institutions of higher education and their students in the West for the benefit of all.

For these organizations, the intern program provides the problem-solving talents of student manpower while making the resources of universities and colleges more available. For institutions of higher education, the program provides relevant field education for their students while building their capacity for problem-solving.

WICHE is an organization in the West uniquely suited for sponsoring such a program. It is an interstate agency formed by the thirteen western states for the specific purpose of relating the resources of higher education to the needs of western citizens. WICHE has been concerned with a broad range of community needs in the West for some time, insofar as they bear directly on the well-being of western peoples and the future of higher education in the West. WICHE feels that the internship program is one method for meeting its obligations within the thirteen western states. In its efforts to achieve these objectives, WICHE appreciates having received the generous support and assistance of the Economic Development Administration; the Jessie Smith Noyes Foundation; the National Endowment for the Humanities; the Wyoming Office of Manpower Planning; and of innumerable local leaders and community organizations, including the agency that sponsored this intern project.

For further information, write Bob Hullinghorst, Director, Resources Development Internship Program, WICHE, P.O. Drawer 'P', Boulder, Colorado 80302 or call (303) 492-7177.

MONTANA
DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

PRESENT AND POTENTIAL LAND USE IN SOUTHEAST MONTANA

STRIPPABLE COAL RESERVES AND AGRICULTURE

David Struck—Resource Geographer
Western Interstate Commission
For Higher Education

Prepared by: Robert C. Ebert
Cartography Bureau
Centralized Services Division

6/1/75

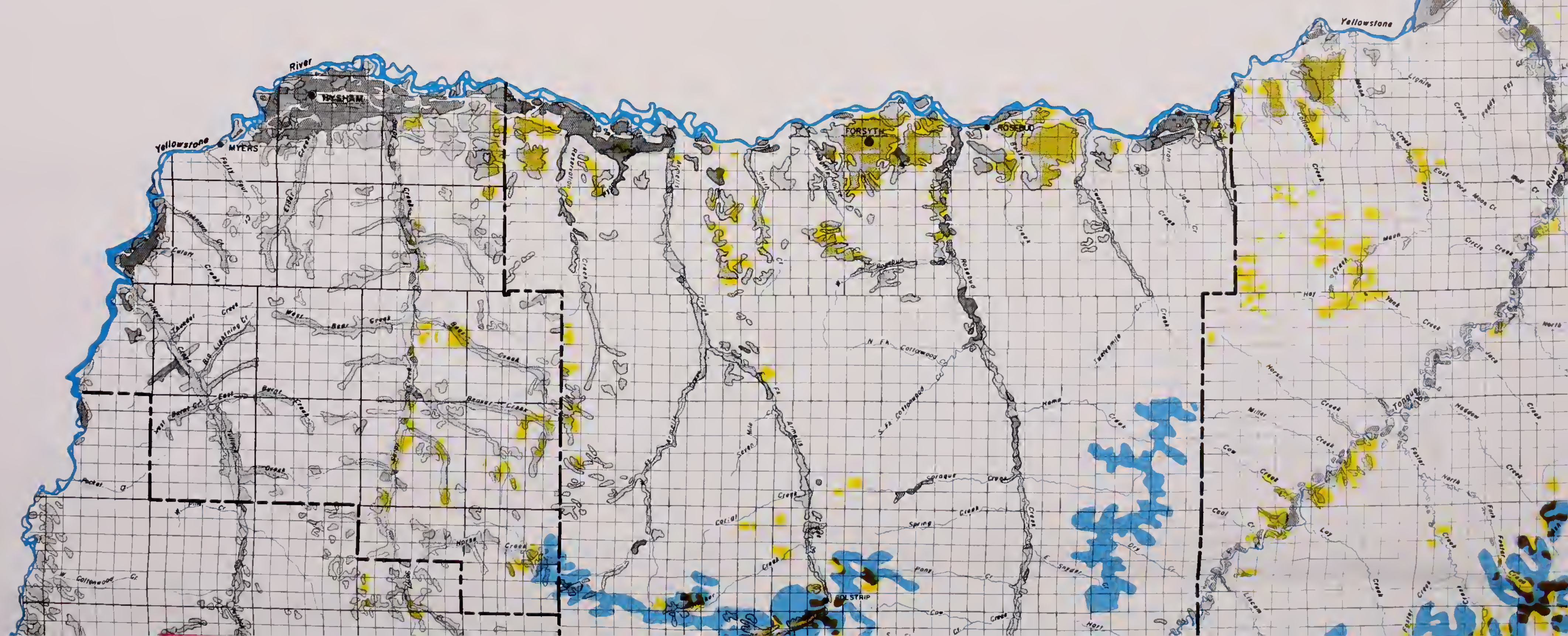
0 2 4 6 8 10 12

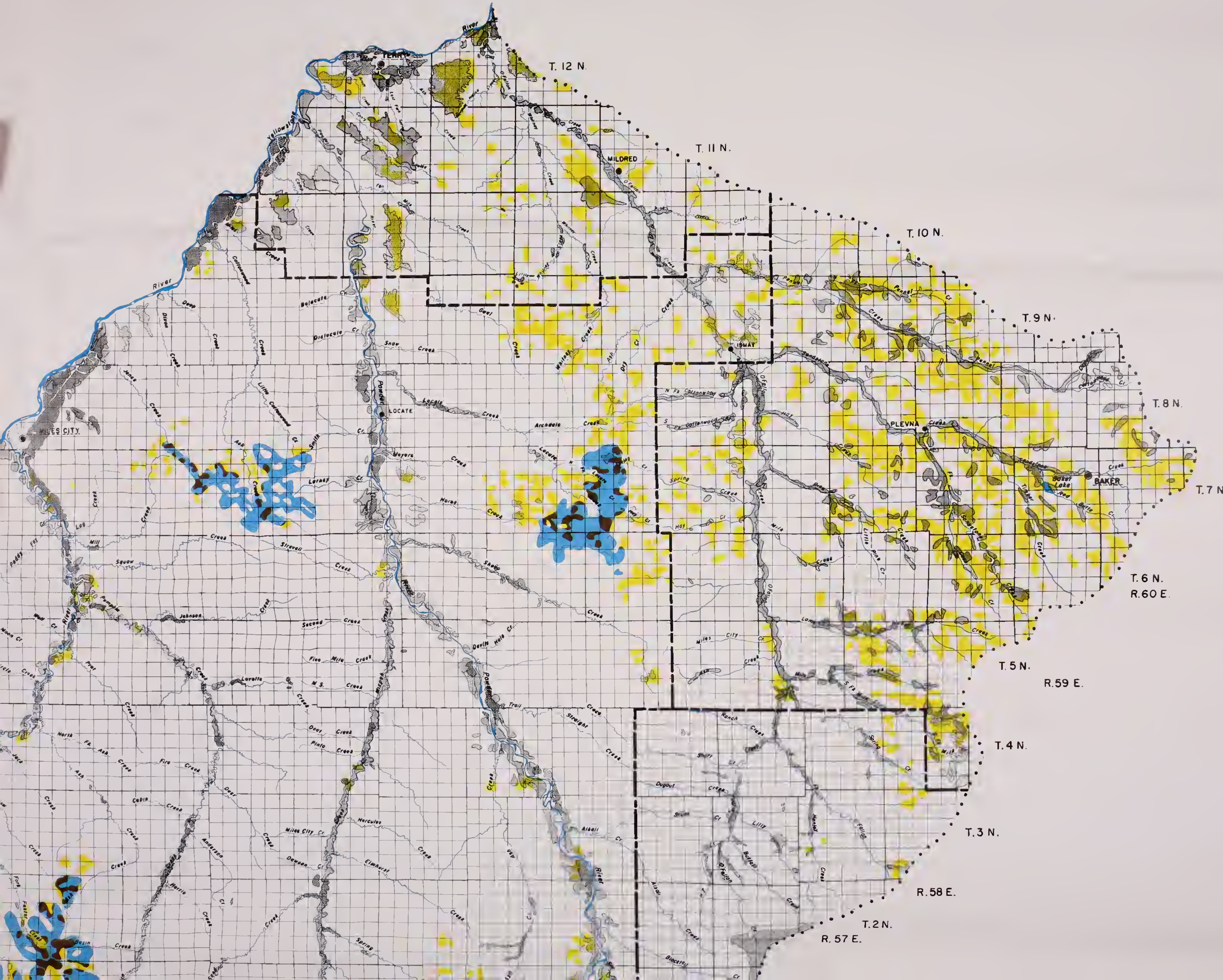
LEGEND

- IRRIGATED LAND
- IRRIGABLE LAND CLASS 1 [1]
- IRRIGABLE LAND CLASS 2 [1]
- IRRIGABLE LAND CLASS 3 [1]
- RANGELAND
- CULTIVATED DRY CROPLAND
- STRIPPABLE COAL (Less than 150' Overburden) [2]
- CULTIVATED DRY CROPLAND UNDERLAIN BY STRIPPABLE COAL.

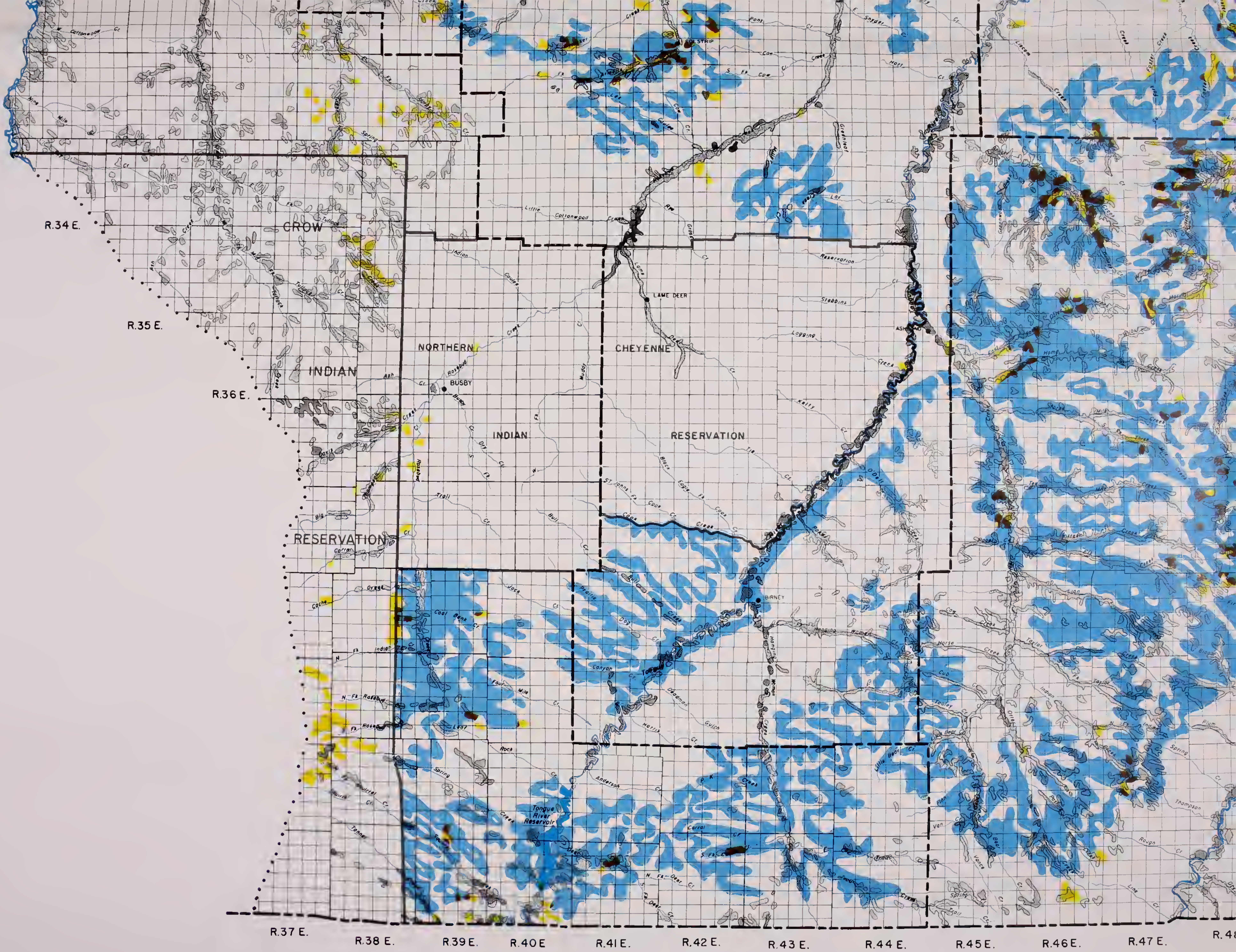
Notes 1/ Irrigable land is land which, because of its soil, topography, and climate, is capable of being irrigated by gravity or sprinkler methods. Such land has been mapped regardless of available water supply. Class I irrigable land has a potentially high productive value; Class 2 is of intermediate value; and class 3 is of the lowest value suitable for irrigation.

2/ Strippable coal on Indian land is not show.





T. 12 N.
T. 11 N.
T. 10 N.
T. 9 N.
T. 8 N.
T. 7 N.
T. 6 N.
R. 60 E.
T. 5 N.
R. 59 E.
T. 4 N.
T. 3 N.
R. 58 E.
T. 2 N.
R. 57 E.
TERRY
MILDRED
ISMAY
PLEVNA
BAKER
LOCATE
MILES CITY
Yellowstone
River



COLSTRIP
R.34 E.
CROW
R.35 E.
INDIAN
R.36 E.
RESERVATION
NORTHERN
BUSBY
INDIAN
CHEYENNE
RESERVATION
LAME DEER
BIRNEY
Tongue River Reservoir
R.37 E.
R.38 E.
R.39 E.
R.40 E
R.41 E.
R.42 E.
R.43 E.
R.44 E.
R.45 E.
R.46 E.
R.47 E.

T.2 N.
R. 57 E.
T.1 N
T.1 S.
T.2 S.
T.3 S.
T.4 S.
T.5 S.
R. 56 E.
T. 6 S.
T. 7 S.
T. 8 S.
R. 55 E.
R. 48 E.
R 49 E.
R.50 E
R.51 E.
R.52 E.
R.53 E.
R.54 E.
N
BROADUS
Vanettes Reservoir
Powder
River
Little Powder River
Little Pilgrim Creek
Pilgrim Creek
Hay Cr.
Timber Creek
Stump Creek
Dry Creek
Blacktail Cr.
Spring Creek
Sand Creek
Corral Creek
Lone Tree Creek
Cache Creek
Rough Creek
Ranch Cr.
Prairie Creek
Bell Creek
Wright Cr.
Cr.